

MEMORANDUM FOR THE RECORD

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: STANDING INSTRUCTIONS: State-sponsored Federal Base Network Surveys

I. GENERAL:

The National Geodetic Survey (NGS) is responsible for defining and managing the Federal Base Network (FBN), a nationwide, 100-kilometer array of permanently monumented geodetic control stations positioned to 1-centimeter network accuracy (95% confidence level) for latitude and longitude, and 2-centimeter network accuracy (95% confidence level) for ellipsoidal height. Working in cooperation with state and local survey organizations, NGS has planned or completed these surveys in 36 states as of December 2001. To support a proposed nationwide datum readjustment, the FBN network should be completed throughout the remaining states by December 2003.

To achieve this goal, state and local surveying organizations in the remaining states must actively participate in the development and observation of their FBN networks. To encourage local participation, NGS will provide increased technical assistance in project planning, observer training, and project supervision. For FBN surveys which meet the minimum requirements described below, NGS will process the data and incorporate the survey results into the National Spatial Reference System (NSRS).

II. PURPOSE:

The FBN survey network will enhance the nation's spatial framework for precision air, sea, and land navigation, mapping and charting, resource management, engineering and cadastral surveys, and Geographic Information Systems. Technology transfer, including training in survey design, data acquisition, and processing, will help to increase local capacity for high-accuracy surveys and NSRS development.

Completion of the FBN will resolve positional discrepancies between existing state High Accuracy Reference Networks and the National Continuously Operating Reference Station (CORS) network, improve the quality and homogeneity of the NSRS, provide the observations necessary for a nationwide datum readjustment, and improve geoid modeling for [height modernization](#) activities.

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III. PROJECT DEVELOPMENT:

The following project development tasks are required:

A. PROJECT COORDINATORS:

The **STATE** and **NGS** shall each designate a point of contact to facilitate communications, training, and data management.

- The **STATE** Project Coordinator is responsible for planning and overseeing the GPS observations, organizing and submitting all raw data, digitizing the bluebook and recovery descriptions, and submitting a field report.
- The **NGS** Project Coordinator is responsible for providing assistance and training for the state coordinator and observers, monitoring project status, and overseeing the final data processing, adjustment, and project report.

B. EDUCATION AND OUTREACH:

- The **STATE** and **NGS** will both attempt to encourage GPS users in the region to participate in the survey.
- **NGS** will maintain a [project website](#) and will conduct local presentations outlining survey objectives and benefits, provide assistance with survey planning, and conduct observer training workshops as necessary.

C. PROJECT PLAN:

- **NGS** will provide lists of minimum requirements and stations to be observed, including the following:

STATION TYPE	MAXIMUM SPACING
FBN stations	100 km
1 st or 2 nd order NAVD 88 bench marks	200 km
CORS or temporary CORS stations	300 km
FBN stations from adjacent projects	as appropriate.

- The **STATE** is encouraged to include additional stations, especially NAVD 88 bench marks and other fiducial control, as these will aid in geoid modeling and network adjustments.
- The **STATE** will conduct field reconnaissance to recover or establish stations of [suitable quality](#).
- The **STATE** will submit a draft project plan, including a station list, project sketch, observing schedule, and a list of proposed instrument types and station monumentation.
- **NGS** will review and approve the state plan or make suggestions if changes are necessary.

IV. DATA ACQUISITION:

The following data acquisition tasks are required:

A. EQUIPMENT:

The **STATE** is responsible for acquiring and calibrating sufficient equipment to accomplish the proposed observation schedule. **NGS** may cooperatively provide some equipment as available. Required equipment includes the following:

- **GPS RECEIVERS** capable of recording dual-frequency full wavelength carrier signals from at least eight satellites. Acquire GPS data at 15-second epoch intervals and 10-degree elevation mask angles.
- **GPS ANTENNAS** with phase center variation patterns listed on the [NGS Antenna Calibration website](#). Note from this website the location of your Antenna's Reference Point (ARP). Antenna height (from station to ARP) must be carefully determined and accurately recorded on observation logs.
- **FIXED-HEIGHT TRIPODS** calibrated at the beginning and end of the project.
- **CAMERAS** (digital preferred) for recording monument and occupation information.

B. OBSERVATIONS:

The **STATE** shall acquire GPS observations in compliance with the following specifications:

- The observation schedule should be designed to maximize the number of baselines observed between adjacent stations. At least half of all baselines shall be repeated.

- Observe each station by one of three methods:
 1. TEMPORARY CORS: Observe one session for at least 72 continuous hours. This is the preferred method for permanent antenna mounts or stations in secure areas.
 2. OTHER STATIONS: Observe at least three independent 5½-hour sessions on different days. The session start times shall include at least one shift of 4 hours or more to include a different satellite configuration.
 3. ADJACENT NETWORKS: Include neighboring stations from completed FBN surveys in at least one 5½-hour session.
- When practicable, use a barometer and psychrometer accurate to 3 mbar and 0.2 C, respectively, for measuring local weather conditions. It is not required to collect meteorological data. However, collection of met data is encouraged if appropriate instruments are readily available; NGS does not recommend buying meteorological instruments solely for this purpose. The data may be useful during the analysis phase, particularly when atmospheric conditions are abnormal or highly variant. It may be possible to avoid reobservations through re-processing with observed meteorological data.
- Conduct all field activities with due regard for the safety of personnel and equipment. Tower contact is mandatory at all controlled airports.
- Provide the NGS Project Coordinator with schedule updates and a weekly progress report. Whenever data quality is questionable, notify the NGS Project Coordinator immediately and submit data for office review.

V. DATA PROCESSING:

The **STATE** will complete the following data processing activities:

- Organize and collate GPS Observation Logs and other forms and photographs. Check all data and forms for completeness and accuracy. Stations with incomplete or conflicting data may be rejected from the project.
- Create the bluebook (B-file) using NGS-CR8BB software.
- Create the descriptions (D-file) using NGS-WDDPROC software.

NGS will complete the following data processing activities:

- Compute GPS baselines in the most current epoch of the International Earth Rotation Service (IERS) Terrestrial Reference Frame (ITRF) system, using NGS-PAGES software, 30-second epoch intervals, 15 degree elevation mask angles, and precise ephemerides from the International GPS Service (IGS).
- Compute CORS and temporary CORS baselines in 24-hour sessions, using the PAGES fixed baseline option.
- Compute long baselines (10 km or longer) in an ion-free, fixed or partially fixed solution.
- Compute shorter baselines in a separate L1 fixed solution.
- Perform three adjustments using NGS-ADJUST software:
 1. Unconstrained survey adjustment.
 2. Constrain ellipsoidal heights and CORS positions.
 3. Constrain orthometric heights.
- Monitor data quality with analysis of PAGES plots, repeated baselines, loop misclosures, free adjustment residuals, and NGS-COMPGB, OBSCHK, OBSDES, and WCHKDESC software. Success in meeting the accuracy standards will be proven by measurement repeatability and adjustment residuals.
- Publish, archive, and distribute survey results and a final project report.

VI. DATA TRANSMITTAL:

The **STATE** will furnish all project deliverables to NGS within 3 months of the final date of observations. **NGS** will complete the data processing activities within 1 year of receipt of state deliverables. Both parties shall retain archive copies of all data until the project is published.

General data format and file definitions are described in "*Input Formats and Specifications of the NGS Data Base.*" Photo requirements are described in "*Requirements for Digital Photographs of Survey Marks & CORS Antennas.*"